CHAPTER 6

TRANSMISSION / SUBSTATION FACILITIES EXPANSION PLAN

CHAPTER 6 TRANSMISSION/SUBSTATION FACILITIES EXPANSION PLAN

This chapter describes the transmission/substation facilities expansion plan for the three cities of Dar es Salaam, Arusha, and Moshi. TANESCO has already formulated a master plan for its power generation facilities and trunk transmission lines up to the year 2025 with the cooperation of Acres International Ltd. of Canada. In preparing the expansion plan, therefore, we assumed the power generation facilities and 220 kV transmission lines to be expanded according to the master plan. In this chapter, we shall focus on the results of our discussions on a plan for expansion of the transmission lines and substations of 132 kV and under. For the distribution network renewal plan, see Chapter 7.

The master plan that was studied first was the most desirable one from technical point of view. According to this master plan, which is based on the 2001-2010 demand forecast, the facilities that are already in overload operation shall be immediately expanded to get rid of the overload operation and any of the other facilities shall be expanded at some future time when the demand reaches its capacity.

This expansion plan contains several unrealistic points. For example, according to this plan, a number of new facilities will be put into operation during 2002. However, the approach we adopted is this. As the first step to prepare an expansion plan, a theoretical expansion plan with every conceivable limitation left out of consideration shall be prepared. After that, such limitations as economic feasibility and implementation timing shall be taken into consideration as required to come up with an optimum master plan.

Therefore, several different master plans appear in this report. The master plan that was formulated first is positioned as the base plan (Case-A). We used this base plan to perform power flow calculations so as to confirm the validity of the original expansion plan. Also, on the basis of the base plan, we prepared alternative expansion plan (Case-B) taking load shedding and overload operation into account. Then, we made an economic analysis of the two plans with the aim of formulating a master plan which is optimum in terms of economics. The results of the economic evaluation are described in detail in Chapter 12. In the detailed design described in Chapter 14, with the aim of preparing a more realistic expansion plan, the time to start the master plan was changed to 2002, any projects that were not on-going at the time of the field survey were deferred until 2003 or subsequent years, and priority was given to the preference of TANESCO (Case-B'). Thus, the master plan (Case-B') described in Chapter 14 is the final master plan formulated by the Study Team.

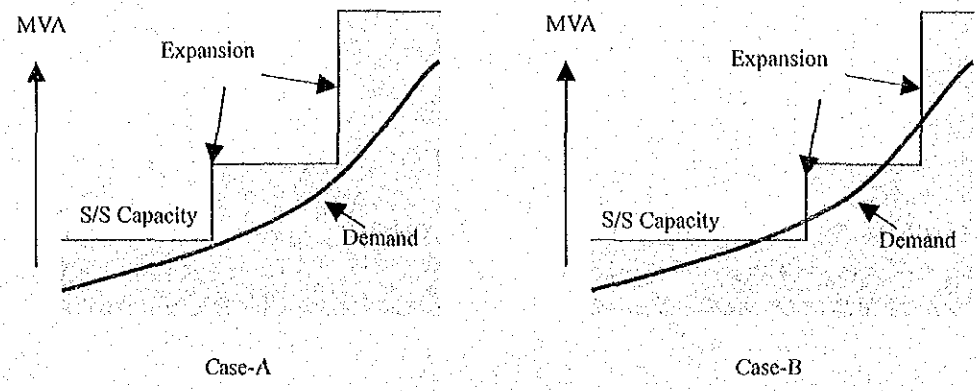

Fig. 6.1 Manner of Substation Expansion

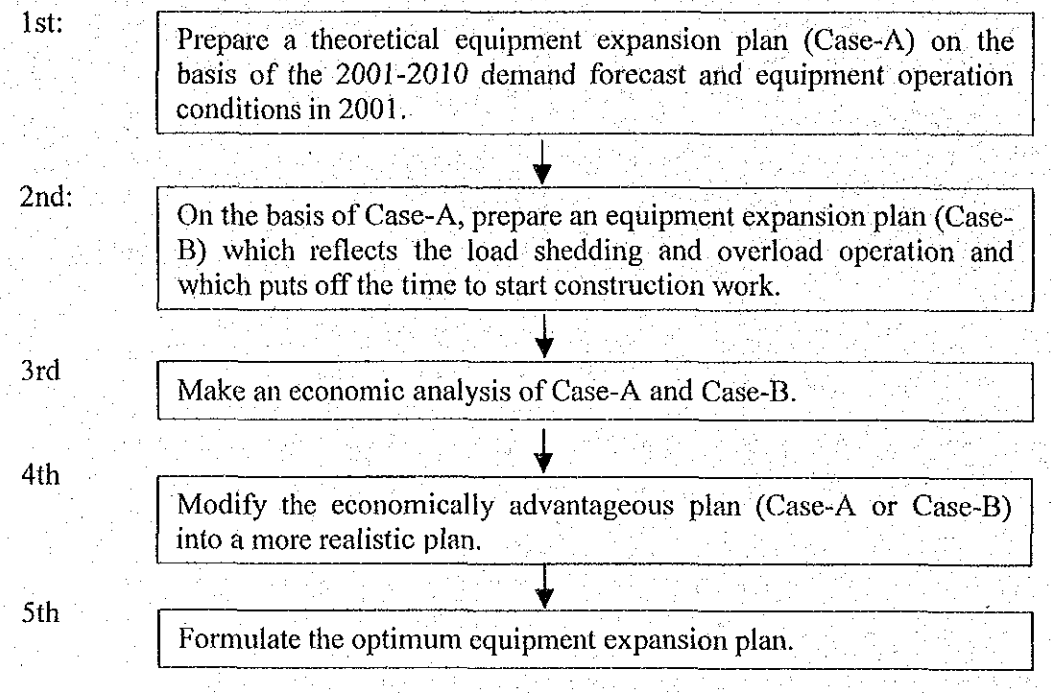

Fig. 6.2 Master Plan Optimization Procedure

6.1 Policy on Preparation of Expansion Plan

The basic policy we adopted in preparing the expansion plan is as follows.

- As described in 4.4 Summary of Results of Demand Forecast, it is the electric power demand for each substation obtained by microscopic forecast that was used as the base for expansion plan. The results of demand forecast are shown in Tables 4.7. 4.9, and 4.11.
- It was decided that a transformer should be expanded at the time when the load at the distribution substation exceeds the transformer capacity. If the transformer continues to be operated under an overload, the time to expand it could be delayed more or less.

However, operating the transformer under an extreme overload continuously can reduce the transformer life. Besides, the actual demand can increase at a rate higher than the forecast rate. It was, therefore, decided that the transformer should be expanded when the load reaches 100% of its capacity.

- Concerning the years in which to construct new substations, the schedule we confirmed with TANESCO was used. Although the forecast demand for each of those new substations, excepting New Oysterbay, is not shown in Table 4.7, 4.9, or 4.11, we used forecast values obtained from TANESCO's regional offices. For each of the new substations for which the regional offices had no forecast values, we assumed that the demand would be 30% of the capacity in the first year of operation and then increase at the rate set by the macroscopic forecast. In addition, for some of the new substations, consideration was given to the distribution of a load to the substation from a neighboring substation. Details are shown in Tables 6.1, and 6.3.
- With the addition of new substations, the total MVA values shown in Tables 6.1 and 6.3 are larger than the total MVA values shown in Tables 4.7, 4.9, and 4.11. The reason for this is that while the latter indicates the demand, the former indicates the distribution substation capacity required for distributing electric energy to meet the demand. Considering such factors as the load imbalance and the equipment maintenance/failure, the equipment must have a capacity somewhat larger than is needed to meet the demand.
- At TANESCO, the standard capacity of a distribution substation transformer was formerly 2.5 MVA or 5 MVA. Now it is 15 MVA in Dar es Salaam and 5 MVA in Moshi and Arusha. Although in Dar es Salaam it was considered possible to employ a larger-capacity transformer (30 MVA) which offers cost and space advantages, all the regional managers seemed unwilling to do so. Probably, the reason for this is that they considered the compatibility with the existing transformers, the security against transformer failure, and the transportation conditions within Tanzania, as well as the fact that TANESCO circulates transformers among the areas as required to cope with a load fluctuation. It was decided, therefore, to use transformers of standard capacity for expansion in Dar es Salaam, except for the City Center S/S that has space limitation. On the other hand, 10MVA transformer is applied to meet increasing demand in Arusha and Moshi.
- Concerning the voltage class of the transmission/transformation systems, we applied 132 kV, 33 kV, and 11 kV which are standard voltages at TANESCO. TANESCO also uses 66 kV as a standard voltage. However, this voltage is not used in Dar es Salaam. In Arusha and Moshi, 66 kV is applied only to the NYM-Kiyungi-Arusha transmission system constructed in the 1960s. Considering the scale of the facilities, it is unwise to introduce a new voltage class in the areas covered by the present study.

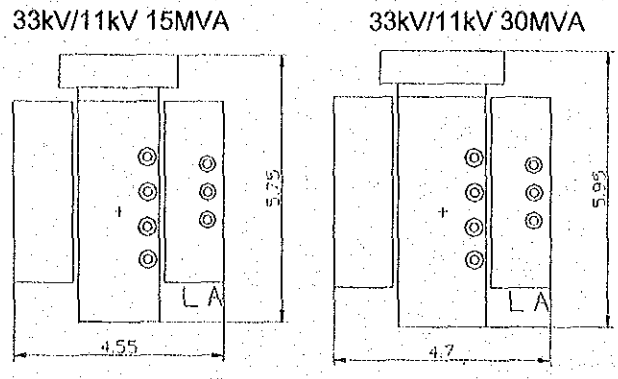

Fig. 6.3. Comparison between 15MVA Tr and 30MVA Tr

6.2 Dar es Salaam

6.2.1 Outline of Expansion Plan

Dar es Salaam has a long-range master plan (1993-2007) based on the "Master Plan Study and Pre-Feasibility Study on Dar es Salaam Power Supply System Expansion" that was made by JICA in 1992 to 1994. Some of the projects included in the master plan have already been carried out with the cooperation of Japan, the World Bank, and NORAD. Since eight years had passed after formulation of that master plan, we made an overall review of the master plan and prepared a new master plan as an expansion plan for 2002-2010 taking into consideration the fluctuation of demand, the construction of new transmission lines and substations, etc. in the past eight years.

The generators of Ubungo connected to a 132 kV bus were included in the power flow calculation, whereas the obsolescent diesel generators connected to a 33 kV or 11 kV bus were excluded from the power flow model because of their comparatively small capacities.

Table 6.2 shows the transmission line/substation expansion plan needed to meet the demand shown in Table 6.1. The results of power flow calculations for the years 2001,2004 and 2010 are shown in Fig. 6.5 through 6.7.

Table 6.1 Demand Forecast from 2001 to 2010 in Dar es Salaam (for Expansion Planning)

Load (MVA)

Name of S/S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Rate	
Mbezi	8.3	9.2	10.3	11.4	12.6	14.0	15.6	17.3	19.2	21.3	11.0%	
Mikocheni	19.0	20.3	21.7	23.3	14.9	16.0	17.1	18.3	19.6	21.0	7.0%	*1
Msasani	11.8	13.6	15.6	17.9	20.6	23.7	27.3	31.4	36.1	41.5	15.0%	
Oysterbay	16.4	17.5	18.7	19.9	21.3	22.7	24.2	25.8	27.6	29.4	6.7%	
New Oysterbay			*15.8*	*16.2*	*16.6*	*17.0*	*17.4*	*17.8*	*18.3*	*18.7*	*2.5%*	*2
Bahari Beach	*12.9*	*13.8*	*14.7*	*15.7*	*16.8*	*17.9*	*19.1*	*20.4*	*21.7*	*23.2*	*6.7%*	*3
Kawe					*4.5*	*4.8*	*5.1*	*5.5*	*5.8*	*6.2*	*8.8%*	*4
Kunduchi						*4.5*	*4.8*	*5.1*	*5.5*	*5.8*	*8.8%*	*4
Kinondoni					*4.5*	*4.8*	*5.1*	*5.5*	*5.8*	*6.2*	*8.8%*	*4
Ilala	40.7	43.4	46.3	49.4	52.7	56.3	60.0	64.1	68.3	72.9	6.7%	
FZ III	16.4	17.8	19.4	21.2	23.1	25.2	27.4	29.9	32.6	35.5	9.0%	
Sokoine	17.1	17.9	18.8	19.8	20.7	21.8	22.9	24.0	25.2	26.5	5.0%	
Citycenter	29.3	31.3	33.4	35.6	38.0	40.6	43.3	46.2	49.3	52.6	6.7%	
Kariakoo	10.7	11.4	12.1	13.0	13.8	14.8	15.7	16.8	17.9	19.1	6.7%	
FZ II	3.9	4.2	4.6	3.9	4.3	4.6	5.0	5.4	5.8	6.3	8.0%	*5
Tabata	*9.1*	*9.6*	*10.0*	*10.5*	*11.1*	*11.6*	*12.2*	*12.8*	*13.4*	*14.1*	*5.0%*	*3
Kitunda				*6.3*	*6.6*	*6.9*	*7.2*	*7.6*	*8.0*	*8.4*	*5.0%*	*3
Muhimbili			*4.5*	*4.8*	*5.1*	*5.5*	*5.8*	*6.2*	*6.6*	*7.1*	*8.8%*	*4
Ubungo	14.0	14.9	15.9	17.0	18.2	19.4	20.7	22.1	23.5	25.1	6.7%	
Tandale	16.9	17.6	18.3	19.0	19.8	20.6	21.4	22.2	23.1	24.1	4.0%	
Magomeni		*4.1*	*4.3*	*4.6*	*4.9*	*5.3*	*5.6*	*6.0*	*6.4*	*6.8*	6.7%	*3
Mburahati				*6.9*	*7.4*	*7.9*	*8.4*	*9.0*	*9.6*	*10.3*	6.7%	*3
UDSM			*4.5*	*4.8*	*5.1*	*5.5*	*5.8*	*6.2*	*6.6*	*7.1*	*8.8%*	*4
Kigogo						*4.5*	*4.8*	*5.1*	*5.5*	*5.8*	*8.8%*	*4
Chang'ombe	11.9	12.7	13.5	14.4	15.4	16.4	17.5	18.7	19.9	21.3	6.7%	
FZ I	7.9	8.4	9.0	9.6	10.2	10.9	11.7	12.4	13.3	14.2	6.7%	
Kurasini	16.3	17.4	18.6	19.8	21.2	22.6	24.1	25.7	27.4	29.3	6.7%	
Mbagala	14.3	15.2	16.2	17.3	18.5	19.7	21.1	22.5	24.0	25.6	6.7%	
Kigamboni	2.5	3.1	3.9	4.9	6.1	7.6	9.5	11.9	14.9	18.6	25.0%	
Yombo				*6.3*	*6.7*	*7.2*	*7.7*	*8.2*	*8.7*	*9.3*	*6.7%*	*3
TOL		*10.0*	*10.7*	*11.4*	*12.1*	*13.0*	*13.8*	*14.8*	*15.7*	*16.8*	*6.7%*	*3
Tandika		*10.0*	*10.7*	*11.4*	*12.1*	*13.0*	*13.8*	*14.8*	*15.7*	*16.8*	*6.7%*	*3
Wazo Tegeta	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	0.0%	*6
Wazo Ubungo	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	0.0%	*6
Tiper												
TAZARA	9.4	10.0	10.6	11.3	11.9	12.5	13.1	13.8	14.4	15.0	+0.5/y	*6
ALAF	12.8	14.0	15.3	16.5	17.8	19.0	20.3	21.5	22.8	24.0	+1.0/y	*6
Friendship	2.5	2.6	2.7	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.0%	
Bagamoyo	1.0	1.1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	*6.7%*	*7
Lower Ruvu	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	0.0%	*7
Zanzibar	33.4	35.9	38.6	41.4	44.5	47.8	51.3	55.1	59.2	63.6	7.4%	
Total (in MVA)	347	471	503	544	581	622	666	713	764	820		

The differences in content from Table 4.7 are as follows.

*1 20% of the load is distributed to Kawe and Kinondoni, respectively.
*2 Consideration is given to the inflow of a load from the neighboring substation.
*3 Fig.s are based on data supplied from TANESCO.
*4 Demand is assumed to be 30% of the capacity in the first year of operation and then grow at 8.8% annually.
*5 20% of the load is distributed to Kitunda.
*6 Included in the "Ubungo 33 kV Lines." in Table 4.7
*7 Estimated from the on-site survey results.

Table 6.2 Expansion Plan from 2002 to 2010 in Dar es Salaam

Year	Name of S/S	Specification	Type	Remark	Name of Transmission Line	Specification	Type	Remark
2002	Mbezi S/S	33kV 15MVAx1	R/E	2x5-->1x15				
	Bahari Beach S/S	33kV 15MVAx1	New	On Going	Tegeta-Bahari Beach	33kV 100mm^2 2cdt 13km	New	On Going 1cct
	Bagamoyo S/S	33kV 5MVAx1	New		Tegeta-Bagamoyo	33kV 100mm^2 2cdt 60km	New	On Going 2cct
	Sokoine S/S	33kV 15MVAx1	Expansion		City Center-Sokoine	33kV 100mm^2 1cdt 3km	Reinforce	
	City Center S/S	33kV Leadout	Expansion	Sokoine Line				
	City Center S/S	33kV 30MVAx1	R/E	1x15-->1x30				
	Kurasini S/S	33kV 15MVAx1	Expansion		Ilala-Kurasini	33kV 150mm^2 1cdt 7.1km	Reconductor	
	Kurasini S/S	Switchgear	Replace					
	Mbagala S/S	33kV 15MVAx1	Expansion					
	Ubungo S/S	33kV 15MVAx1	Expansion	On Going				
	Mikocheni S/S	33kV 15MVAx1	Expansion					
	Tandale S/S	33kV 15MVAx1	Expansion		Ubungo-Tandale Tap	33kV 100mm^2 2cdt 1km	New	2cct
	Magomeni S/S	33kV 15MVAx1	New	On Going	Magomeni-Magomeni Tap	33kV 100mm^2 1cdt 1km	New	
	FZ III S/S	33kV 15MVAx1	Expansion					
	Tandika S/S	33kV 15MVAx1	New		FZ III-Tandilka	33kV 100mm^2 2cdt 5km	New	1cct
	FZ III S/S	33kV Leadout	Expansion	Tandika Line				
	FZ I S/S	Panel, others	Replace					
	FZ II S/S	Switchgear etc	Replace					
2003	Ilala S/S	33kV 15MVAx1	Expansion					
	Muhimbili S/S	33kV 15MVAx1	New		Ilala-Muhimbili	33kV 100mm^2 1cdt 6km	New	
	Ilala S/S	33kV Leadout	Expansion	Muhimbili Line				
	TOL S/S	33kV 15MVAx1	New		Ilala-TOL	33kV 100mm^2 2cdt 5km	New	1cct
	Ilala S/S	33kV Leadout	Expansion	TOL Line				
	University S/S	33kV 15MVAx1	New		Ubungo-University	33kV 100mm^2 1cdt 7km	New	
	Ubungo S/S	33kV Leadout	Expansion	University Line				
	New Oysterbay S/S	132kV 45MVAx2 33kV 15MVAx2	New		Ubungo-New Oysterbay	132kV 240mm^2 1cdt 8.5km	New	
	Ubungo S/S	132kV Leadout	Expansion	NOB Line				
	Oysterbay S/S	33kV 15MVAx1	R/E	2x5-->1x15	New Oysterbay-Oysterbay	33kV 150mm^2 2cdt 1.6km	New	1cct
	Msasani S/S	33kV 15MVAx1	Expansion		New Oysterbay-Msasani	33kV 150mm^2 2cdt 5km	New	1cct
2004	Bahari Beach S/S	33kV 15MVAx1	Expansion					
	Tegeta S/S	33kV Leadout	Expansion	Bahari Beach Line				
	Mburahati S/S	33kV 15MVAx1	New		Ubungo-Mburahati	33kV 100mm^2 1cdt 4km	New	
	Ubungo S/S	33kV Leadout	Expansion	Mburahati Line				
	Yombo S/S	132kV 45MVAx1	New		FZ III-Yombo	132kV 240mm^2 1cdt 8.5km	New	
		33kV 15MVAx1	New					

R/E: Replace and Expansion

Year	Name of S/S	Specification	Type	Remark	Name of Transmission Line	Specification	Type	Remark
2004	FZ III S/S	132kV Leadout	Expansion	Yombo Line				
					Yombo-Mbagala	132kV 240mm^2 1cdt 10km	New	
	Kitunda S/S	33kV 15MVAx1	New		Yombo-Kitunda	33kV 100mm^2 1cdt 3.9km	New	
	Mbagala S/S	132kV 45MVAx1	Expansion		Kurasini-Mbagala	132kV 240mm^2 1cdt 16km	New	
	Kurasini S/S	132kV 45MVAx2	Expansion		Ilala-Kurasini	132kV 240mm^2 1cdt 10km	New	
	Ilala S/S	132kV Leadout	Expansion	Kurasini Line				
2005	Kawe S/S	33kV 15MVAx1	New		Mbezi-Kawe	33kV 100mm^2 1cdt 9km	New	
	Mbezi S/S	33kV Leadout	Expansion	Kawe Line				
	Kinondoni S/S	33kV 15MVAx1	New		Mikocheni-Kinondoni	33kV 100mm^2 1cdt 8km	New	
	Mikocheni S/S	33kV Leadout	Expansion	Kinondoni Line				
	Chang'ombe S/S	33kV 15MVAx1	Expansion		Kurasini-Chang'ombe	33kV 120mm^2 1cdt 3km	Reinforce	
2006	Kunduchi S/S	33kV 15MVAx1	New		Tegeta-Kunduchi	33kV 100mm^2 1cdt 3.2km	New	
	Tegeta S/S	33kV Leadout	Expansion	Kunduchi Line				
	City Center S/S	33kV 30MVAx1	R/E	1x15-->1x30				
	Kigogo S/S	33kV 15MVAx1	New		Ilala-Kigogo	33kV 100mm^2 1cdt 12km	New	
	Ilala S/S	33kV Leadout	Expansion	Kigogo Line				
	Kurasini S/S	33kV 15MVAx1	Replace					
	Ilala S/S	132kV 45MVAx1	Expansion		Ubungo-Ilala	132kV 240mm^2 1cdt 7.5km	Reinforce	
		33kV 15MVAx1	Expansion		Ilala-City Center #2	33kV 100mm^2 1cdt 2.8km	Reconductor	1cct
2007	Mbezi S/S	33kV 15MVAx1	Expansion		Tegeta-Mbezi	33kV 100mm^2 1cdt 8.4km	Reinforce	
	Tegeta S/S	33kV Leadout	Expansion	Mbezi Line				
	Kariakoo S/S	33kV 15MVAx1	Expansion		Ilala-Kariakoo	33kV 100mm^2 1cdt 1.3km	Reinforce	
	Ilala S/S	33kV Leadout	Expansion	Kariakoo Line				
2008	Msasani S/S	33kV 15MVAx1	Expansion					
2009	TOL S/S	33kV 15MVAx1	Expansion					
	Ilala S/S	33kV Leadout	Expansion	TOL Line				
	FZ III S/S	33kV 15MVAx1	Expansion					
	Tandika S/S	33kV 15MVAx1	Expansion					
	FZ III S/S	33kV Leadout	Expansion	Tandika Line				
	Ubungo S/S	132kV 50MVAx1	Expansion					
2010								

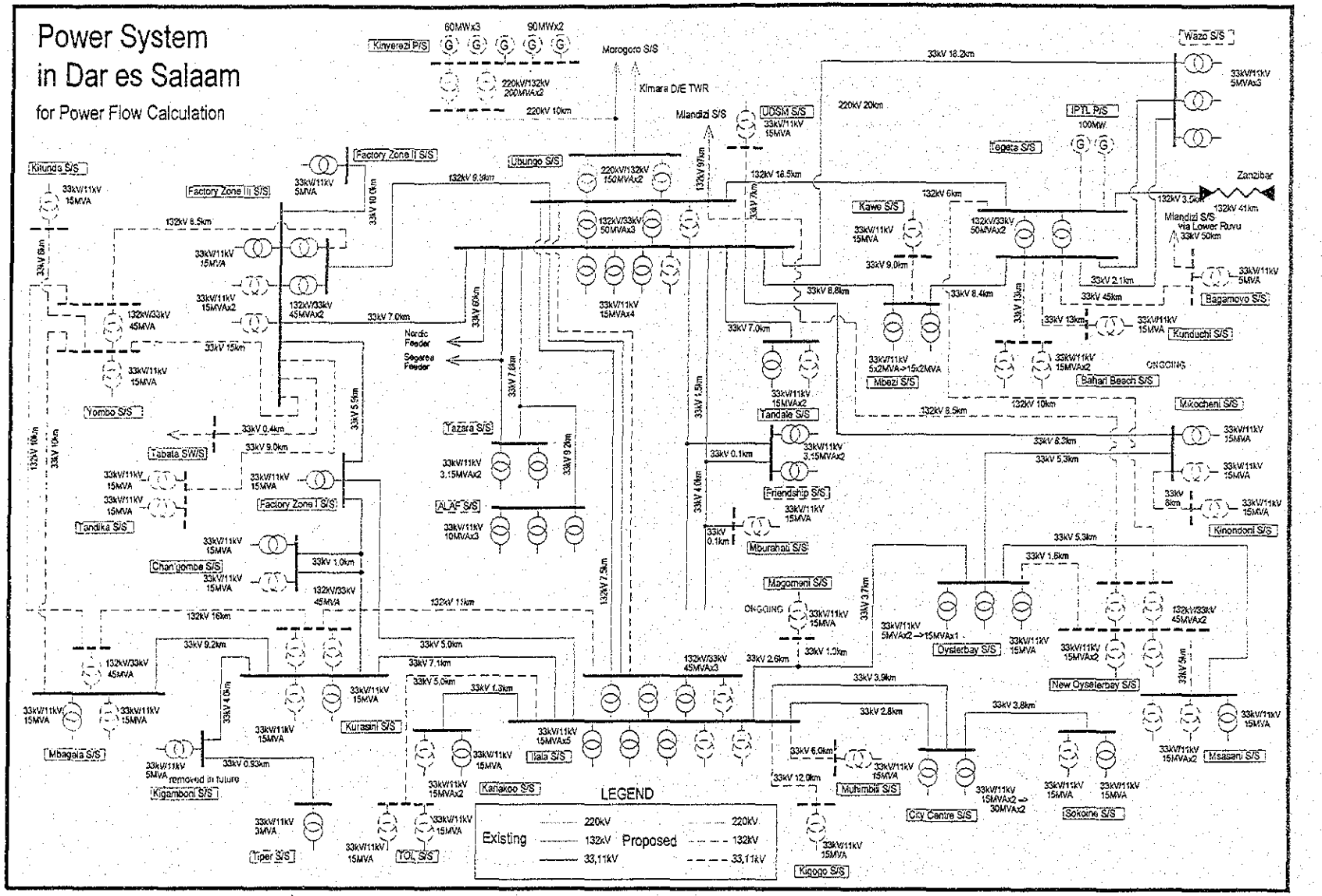

Fig. 6.4 Power System Diagram in Dar es Salaam

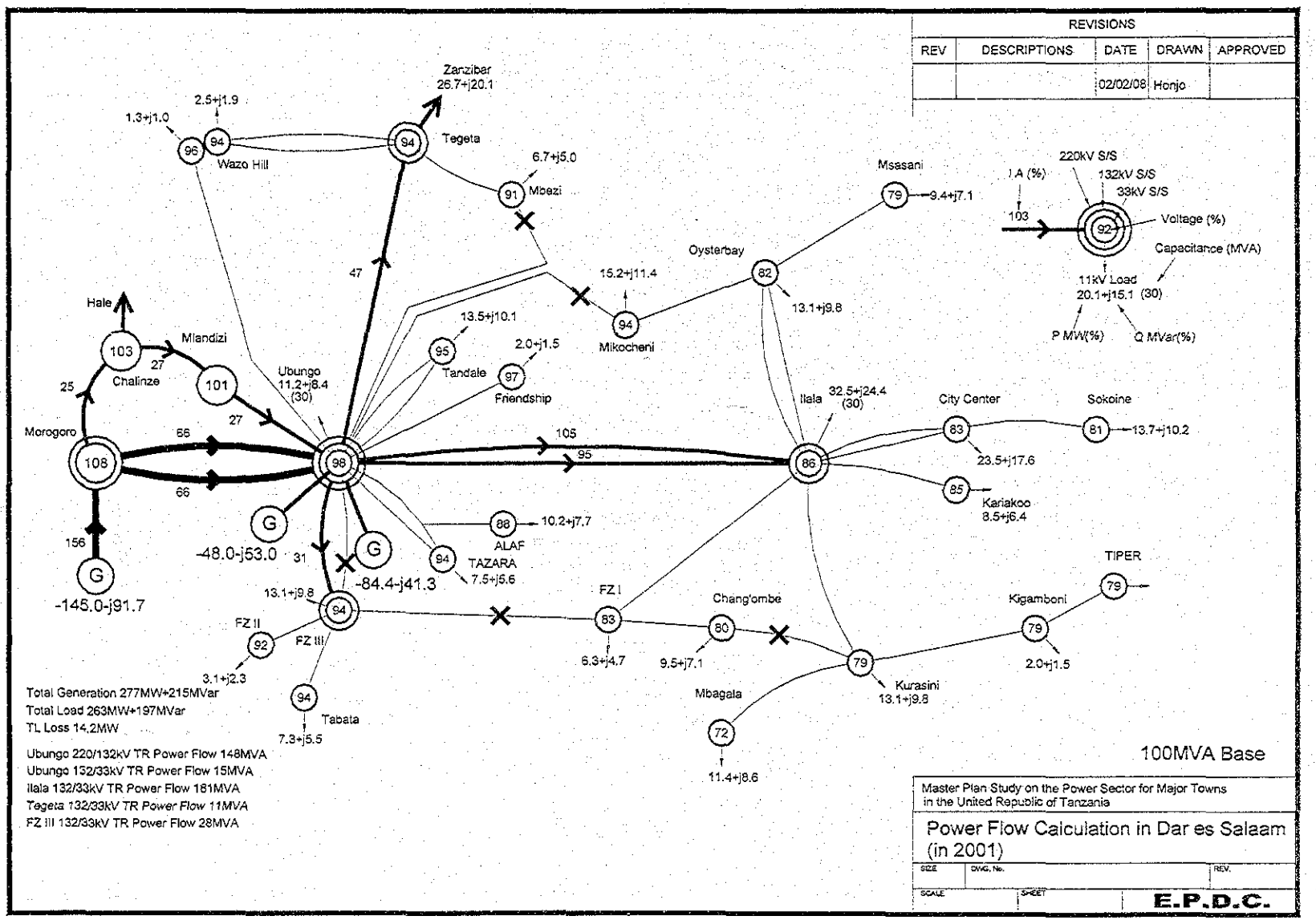

Fig. 6.5 Power Flow Calculation in Dar es Salaam 2001

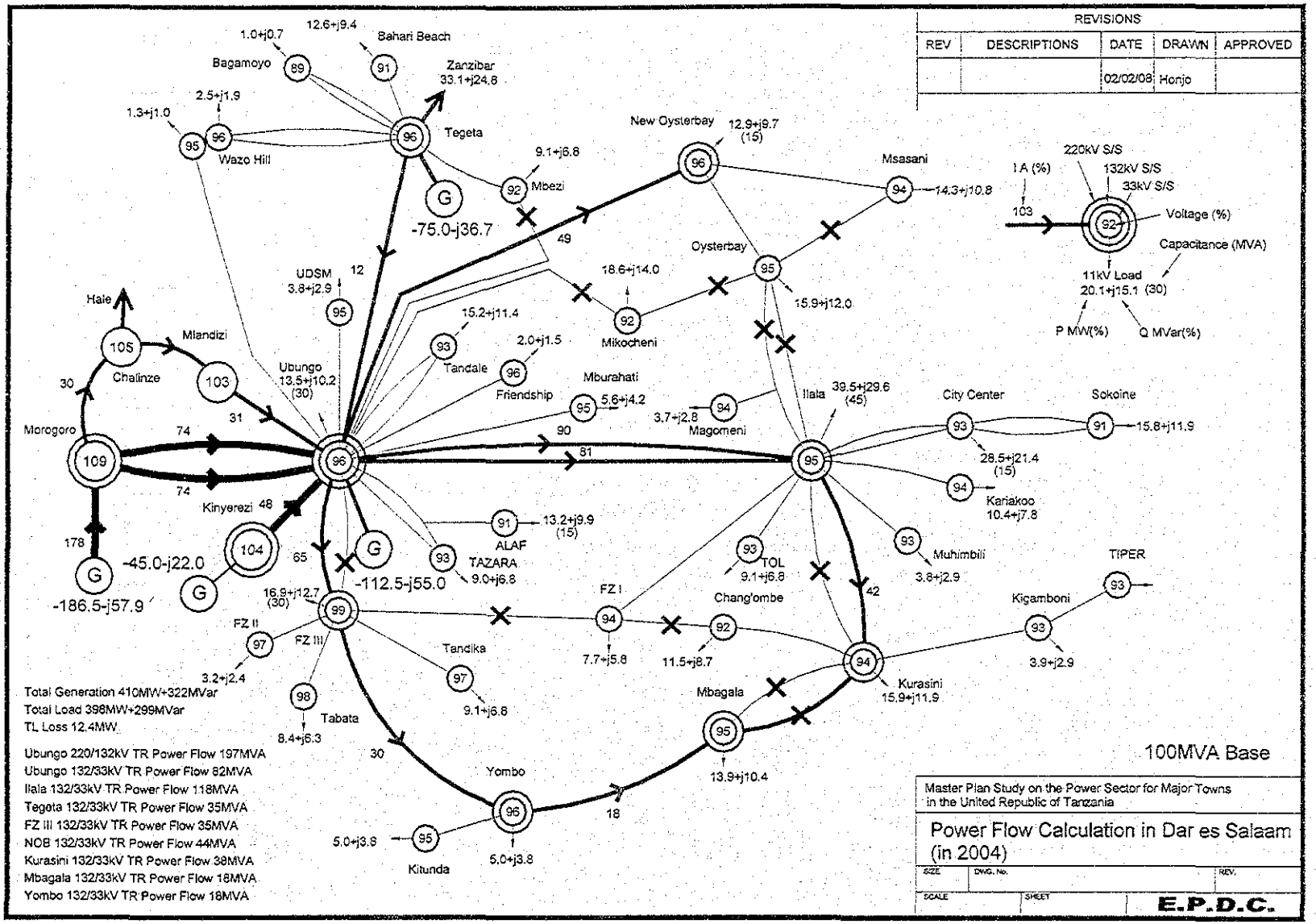

Fig. 6.6 Power Flow Calculation in Dar es Salaam 2004

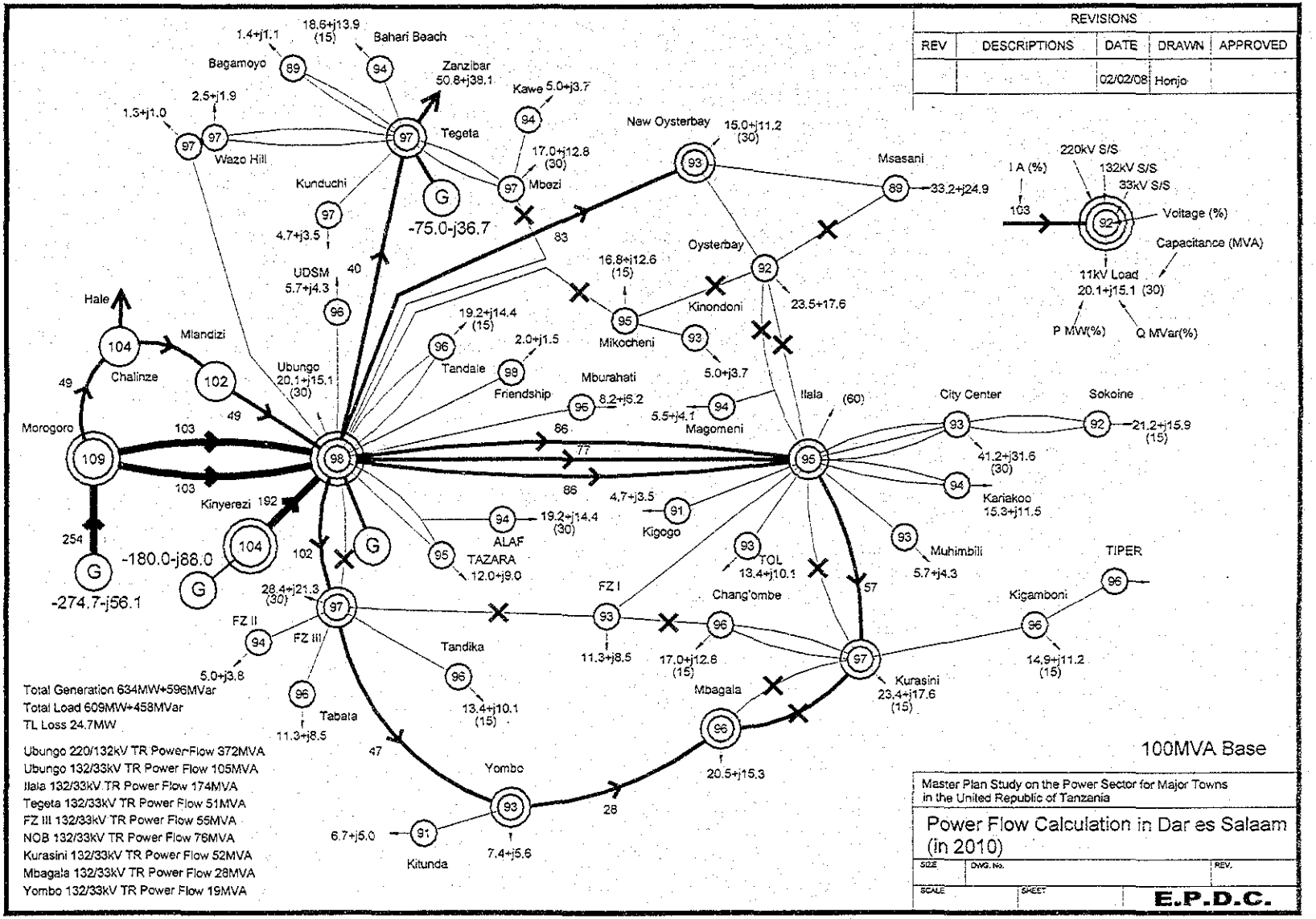

Fig. 6.7 Power Flow Calculation in Dar es Salaam 2010

6.2.2 Concept of Expansion Plan for Each Year

(1) 2001

According to the data obtained from TANESCO and the on-site study results, the Mikocheni S/S, FZ III S/S, Sokoine S/S, Tandale S/S, and Kurasini S/S have been overloaded, and the Mbagala S/S is approaching its rated load. It is to be desired that all these substations should be expanded as early as possible. Although the 132 kV/33 kV transformer of the Ilala S/S is also under an overload, this problem will be dissolved by the load switching after completion of the New Oysterbay S/S in 2003 and by the boosting of voltage of the Kurasini S/S-Mbagala S/S-Tombo S/S transmission line in 2004.

(2) 2002

The Bahari Beach S/S, Magomeni S/S, and Ubungo S/S are being constructed or rehabilitated with the cooperation of some donor countries other than Japan. It is expected that these substations will be put into operation in 2002. Whether there are concrete plans to start construction of a new substation in the near future has not been confirmed. Concerning the substations that were under an overload and the facilities that had serious troubles in 2001, they are to be expanded or renewed preferentially during 2002. The City Center S/S has two 33 kV, 15 MVA transformers made in 1979 and an empty space for one more transformer. Since the two transformers have been overloaded for a long time, the one that is worse in condition shall be replaced with a new 30 MVA transformer. This substation, located in the center of Dar es Salaam, is fed by the Ilala S/S over a large-capacity 33 kV transmission line. Since the substation site is not very spacious, a 30 MVA transformer shall be adopted.

(3) 2003

Construction of the New Oysterbay S/S is one of the most urgent projects that are included in the Master Plan. However, with consideration given to the construction period required of a 132 kV substation, the New Oysterbay S/S is planned to be put into operation in 2003. Then, the Oysterbay S/S and Msasani S/S that have been fed by the Ilala S/S will be switched to the New Oysterbay S/S, hence the 132 kV/33 kV transformers of the Ilala S/S will be reduced in load. Concurrently with the construction of the New Oysterbay S/S, the obsolescent 5 MVA transformer of the Oysterbay S/S is planned to be renewed. In the area around the site of the New Oysterbay S/S, the demand for electric power is rapidly increasing. Therefore, considering the possibility of a failure of the 132 kV Ubungo-New Oysterbay transmission line, it is recommended that the 33 kV transmission lines around the New Oysterbay S/S be of large capacity.

In 2003, there are also plans to construct three new 33 kV substations—Muhimbili, TOL, and UDSM. In addition, the Ilala S/S is to be expanded in this year since the 33 kV load exceeds the transformer rated capacity.

(4) 2004

In the former Master Plan, it was planned to sequentially upgrade the substation voltage to 132 kV at the Yombo S/S (in 2000), Kurasini S/S (in 2002), and Mbagala S/S (in 2006). In the new Master Plan, however, it was decided to simultaneously boost the voltages of the three substations in the southern part of Dar es Salaam in 2004. This is to dissolve the problem of overload with the 132 kV Ubungo-Ilala transmission line and the

132 kV/33 kV transformer of the Ilala S/S and secure the necessary power supply capacity in the case of a failure of the 132 kV Ubungo-Ilala transmission line. According to the results of power flow calculations, the power flow of the 132 kV Ubungo-Ilala transmission line will become 172 MVA in 2003. The capacity of this transmission line is 105 MVA for the #1 line and about 137 MVA for the #2 line. Therefore, if either one fails, the other transmission line is overloaded. By completing a 132 kV Ilala S/S-Kurasini S/S-Mbagala S/S-Yombo S/S-FZ III S/S transmission line, it is possible to reduce the above power flow and at the same time, ease the overload of the 132 kV/33 kV transformer of the Ilala S/S. Since the Kurasini S/S feeds the 33 kV transformers of the Chang'ombe S/S and Kurasini S/S, as well as the 33 kV feeder of Kigamboni that is expected to be developed in the future, two 132 kV, 45 MVA transformers shall be newly installed in the Kurasini S/S.

The upgrade of voltage permits the Kurasini S/S to feed the Chang'ombe S/S that has been fed by the Ilala S/S. Then, the 132 kV transmission line between the Mbagala S/S and Kurasini S/S will normally be kept open.

(5) 2005

Two new 33 kV substations Kawe and Kinondoni are planned to be committed. In addition, the Chang'ombe S/S is to be expanded as its load exceeds the rated capacity.

(6) 2006

Even if the load is distributed to the three 132 kV substations—New Oysterbay, Kurasini, and Mbagala, it is necessary to expand the 132 kV/33 kV transformer of the Ilala S/S in this year. At the same time, the transmission line between Ubungo and Ilala needs to be expanded. At present, only the #2 line is laid on a steel tower which is capable of accommodating two lines. Since the additional line shall be laid on this steel tower, there is no need to secure anything extra for the expansion. In addition, the existing 33 kV transformers of the City Center S/S and Kurasini S/S are planned to be replaced with new ones in this year.

The Ilala S/S and the City Center S/S are connected by two 33 kV transmission lines which are different in type and length. The #1 line is a two-conductor (150 mm^2 x 2) cable having a length of 3.9 km, whereas the #2 line is a single-conductor (100 mm^2) cable having a length of 2.8 km. The transmission capacity is 53 MVA for the #1 line and 20 MVA for the #2 line. Since the #2 line is overloaded, it shall be replaced with a two-conductor (100 mm^2 x 2) cable.

(7) 2007

In this year, the transformers of the Mbezi S/S and Kariakoo S/S need to be expanded. In addition, the 132 kV/33 kV transformer of the Ubungo S/S must be expanded.

(8) 2008-2010

In the last stages of the Master Plan, no major changes are planned to be made to the system configuration, except that an additional 33 kV transformer shall be installed in each distribution substation which will have been overloaded.

6.2.3 Supplementary Explanation

In the Master Plan, it has been decided that the upgrading of voltage of the City Center S/S to 132 kV that was included in the former Master Plan shall not be effected because of several problems involved in securing the site, etc. Concerning the Mbezi S/S, it was judged unnecessary to upgrade its voltage until 2010 because the New Oysterbay S/S is planned to be constructed in its neighborhood and the 132 kV/33 kV transformer of the Tegeta S/S has pretty much time before the load reaches its rated capacity. In the future, construction of a 132 kV loop of the Ubungo S/S, Tegeta S/S, Mbezi S/S, and New Oysterbay S/S will contribute to the improvement in the reliability of power supply in the northern part of Dar es Salaam. The results of the present study show that when the IPTL P/S in Tegeta is put into operation, the 132 kV transmission line between the Ubungo S/S and the Tegeta S/S will decrease in load. In addition, based on the demand forecast up until 2010, it is considered possible to back up the transmission line with a 33 kV transmission line. Therefore, the 132 kV loop must not necessarily be constructed by 2010. In order to maintain the voltage, it is necessary to install a capacitor bank of about 30 MVA/year within the city of Dar es Salaam.

6.3 Arusha and Moshi

6.3.1 Outline of Expansion Plan

For the transmission lines and substations in Arusha and Moshi, a master plan like the one for Dar es Salaam has not been formulated. Instead, the individual Regional Offices of TANESCO study plans for construction of transmission lines and substations in cooperation with the city's urban planning department, etc. In Arusha and Moshi, respectively, the Study Team made a demand forecast, carried out a field investigation of the planned sites of new substations and the planned transmission line routes, and formulated an expansion plan in cooperation with the regional offices.

Arusha and Kilimanjaro Regions are grid-connected to the 220 kV system at Njiro and to the hydropower stations of the Pangani river system by the 132 kV Hale-Same-Kiyungi transmission line. In addition, they receive power from the NYM Power Station over a 66 kV transmission system. However, this power station has a small rated output (8 MW) and is positioned as a supplementary power source.

The 220 kV transmission line that is fed to Arusha is planned to be duplicated by 2010. In the future, both of Arusha and Kilimanjaro Regions are to be led by the 220 kV grid via the 220 kV/132 kV transformers of the Njiro S/S. The 132 kV transmission line that is led from the Hale S/S to the Kiyungi S/S is a long-distance transmission line constructed in 1975. This line has a transmission capacity of about 60 MW and is worthy of expansion from the viewpoint of nation wide network planning. However, it was left out of consideration since it does not belong to any of the areas covered by the present study.

Arusha and Moshi are local cities on the national road that links Nairobi, Kenya and Dar es Salaam. Although the two cities are about 70 km apart, they have close connections regionally. Electrically too, they are linked by a 132 kV and 66kV transmission line. Since it is considered that for the electrical systems of both cities the 220 kV network that links to Arusha will become the main power source in the future, we formulated an expansion plan for the two cities put together.

Table 6.4 shows the transmission line/substation expansion plan that is needed to meet the demand shown in Table 6.3.

The results of power flow calculations for the years for the years 2001,2004 and 2010 are shown in Fig.s 6.9 through 6.11.

Table 6.3 Demand Forecast from 2001 to 2010 in Arusha and Moshi (for Expansion Planning)

Load (MVA) Arusha

Name of S/S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Rate
Unga LTD	13.9	14.9	15.9	17.0	18.2	19.5	20.9	22.3	23.9	25.6	7.0%
Mt. Meru	14.7	16.5	18.4	20.7	23.1	25.9	29.0	30.0	30.0	30.0	12.0%
Themi	2.8	3.1	3.4	3.8	4.2	4.7	5.2	5.8	6.4	7.1	11.0%
Kiltex	2.7	2.9	3.1	3.4	3.7	4.0	4.3	4.6	5.0	5.4	8.0%
33kV Load	13.3	14.6	16.1	17.7	19.4	21.4	23.5	25.9	28.5	31.4	
Usa River	*5.0*	*5.5*	*6.1*	*6.7*	*7.3*	*8.1*	*8.9*	*9.7*	*10.7*	*11.8*	*10.0%*
Tengeru	*1.0*	*1.1*	*1.2*	*1.3*	*1.4*	*1.6*	*1.7*	*1.9*	*2.0*	*2.2*	*9.2%*
Sakina				*3.0*	*3.3*	*3.6*	*3.9*	*6.8*	*11.1*	*15.9*	*9.2%*
Monduli			*3.0*	*3.3*	*3.6*	*3.9*	*4.3*	*4.7*	*5.1*	*5.6*	*9.2%*
Njiro B					*3.0*	*3.3*	*3.6*	*3.9*	*4.3*	*4.7*	*9.2%*
Total (in MVA)	53.3	58.5	67.2	76.8	87.3	95.9	105.3	115.6	127.1	139.7	

Load (MVA) Kilimanjaro

Name of S/S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Rate
Boma Mbuzi	17.6	15.0	15.9	17.0	18.1	19.3	20.5	21.8	23.3	24.8	6.5%
Marangu Rombo	4.9	5.3	5.8	6.3	6.9	7.5	8.1	8.8	9.6	10.5	8.8%
Trade School	7.6	8.3	9.0	7.8	8.5	9.3	10.1	11.0	12.0	13.0	8.8%
Machame	2.6	2.8	3.1	3.3	3.6	3.9	4.3	4.7	5.1	5.5	8.8%
NYM & Mwanga	5.2	5.6	6.1	6.7	7.2	7.9	8.6	9.3	10.1	11.0	8.8%
Mwanga	0.8	0.9	1.0	1.1	1.1	1.2	1.4	1.5	1.6	1.7	8.8%
Same	1.5	1.6	1.8	1.9	2.1	2.3	2.5	2.7	2.9	3.2	8.8%
Gonja	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	8.8%
Lawate	1.6	1.7	1.9	2.0	2.2	2.4	2.1	2.3	2.5	3.7	8.8%
KIA	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0%
TPC	5.0	5.4	5.9	6.4	7.0	7.6	8.3	9.0	9.8	10.7	7.9%
YMCA		*3.0*	*3.3*	*3.6*	*3.9*	*4.2*	*4.6*	*5.0*	*5.4*	*5.9*	*8.8%*
Gomberi						*1.5*	*1.6*	*1.8*	*1.9*	*2.1*	*8.8%*
KCMC				*3.0*	*3.3*	*3.6*	*3.9*	*4.2*	*4.6*	*5.0*	*8.8%*
Boma Ngombe							*1.5*	*1.6*	*1.8*	*1.9*	*8.8%*
Total (in MVA)	47.5	50.4	54.5	59.9	64.8	71.6	76.8	83.1	89.9	98.2	

Generation(MVA)

Name of P/S	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Remark
NYM	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	pf=0.9

The differences in contents from Tables 4.9 and 4.11 are as follows.

*1 The overload is distributed to the Sakina S/S.
*2 Calculated for the Industrial-Usa River-Tengeru line; included in the "Tengeru and Others" in Table 4.9.
*3 5 MVA 10%/year in 2001.
*4 5 MVA 10%/year in 2001.
*5 The demand is assumed to be 30% of the rated load in the first year of operation and then increase at 9.2% annually; consideration is given to the overload of the Mt. Meru S/S.
*6 The demand is assumed to be 30% of the rated load in the first year of operation and then increase at 9.2% annually.
*7 Estimated values.
*8 5 MVA 7.9%/year in 2001.
*9 The demand is assumed to be 30% of the rated load in the first year of operation and then increase at 8.8% annually.

Table 6.4 Expansion Plan from 2002 to 2010 in Arusha and Moshi

Year	Name of S/S	Specification	Type	Remark	Name of Transmission Line	Specification	Type	Remark
2002	Njiro S/S	Switchgear	Replace					
		132kV 45MVAx1	Expansion					
	Mt. Meru S/S	33kV 10MVAx3	Expansion		Njiro-Mt.Meru	33kV 100mm^2 7.3km	Reinforce	
	Kiyungi S/S	Switchgear etc	Replace					
		132/33kV 45MVAx1	Expansion					
	Boma Mbuzi S/S	Switchgear etc	Replace		Kiyungi-Boma Mbuzi	33kV 100mm^2 7km	Reinforce	
		33kV 10MVAx1	Expansion					
	Trade School S/S	33kV 10MVAx1	R/E		Kiyungi-Trade School	33kV 100mm^2 10km	Reinforce	
	Machame S/S	33kV 5MVAx1	R/E	1x2.5-->1x5				
	YMCA S/S	33kV 10MVAx1	New	On going				
	Marangu Sw/S	33kV	New		Kiyungi-Marangu	33kV 100mm^2 43km	New	
2003	Unga LTD S/S	33kV 10MVAx3	R/E	2x5-->3x10	Njiro-Unga LTD	33kV 100mm^2 5.8km	Reinforce	
	Kiltex S/S	33kV 10MVAx1	R/E	1x5-->1x10				
	Usa River S/S	33kV 10MVAx1	New		Njiro-Usa River	33kV 100mm^2 21.3km	New	
					Tengeru-Usa River	33kV 100mm^2 12.5km	New	
	Monduli S/S	33kV 10MVAx1	New		Njiro-Monduli	33kV 100mm^2 38.6km	New	
	Same S/S	Switchgear etc	Replace					
2004	Sakina S/S	33kV 10MVAx1	New		Njiro-Sakina	33kV 100mm^2 13.2km	New	
					Mt.Meru-Sakina	33kV 100mm^2 8.1km	New	
	KCMC S/S	33kV 10MVAx1	New		Trade School-KCMC	33kV 100mm^2 3.7km	New	
	Trade School S/S	33kV Leadout	Expansion	KCMC Line				
2005	Njiro B S/S	33kV 10MVAx1	New		Njiro-Njiro B	33kV 100mm^2 3km	New	
					Njiro-Kiyungi	132kV 240mm^2 70km	Reinforce	(1/2)
2006	Njiro S/S	220kV 60MVAx1	Expansion					
		132kV 45MVAx1	Expansion		Njiro-Kiyungi	132kV 240mm^2 70km	Reinforce	(2/2)
	Gomberi S/S	33kV 5MVAx1	New		KCMC-Gomberi	33kV 100mm^2 4.9km	New	
	KCMC S/S	33kV Leadout	Expansion	Gomberi Line				
	Kiyungi S/S	132kV Leadout	Expansion	Njiro Line				
2007	Themi S/S	33kV 10MVAx1	Expansion					
	Boma Ngombe S/S	33kV 5MVAx1	New					
2008								
2009	Usa River S/S	33kV 10MVAx1	Expansion					
	Sakina S/S	33kV 10MVAx1	Expansion					
	Kiyungi S/S	132/33kV 45MVAx1	Expansion					
2010								

R/E: Replace and Expansion

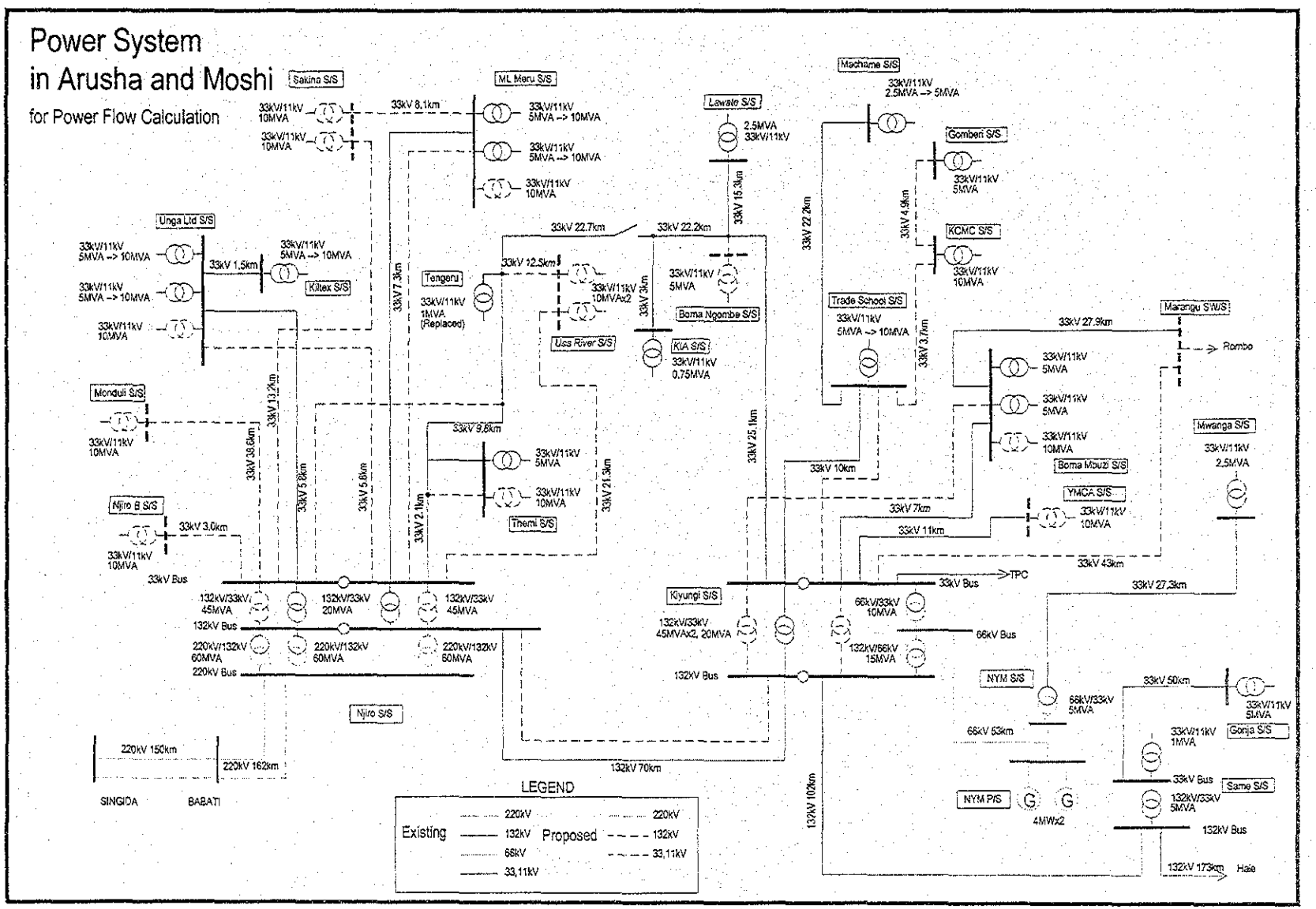

Fig. 6.8 Power System Diagram in Arusha and Moshi

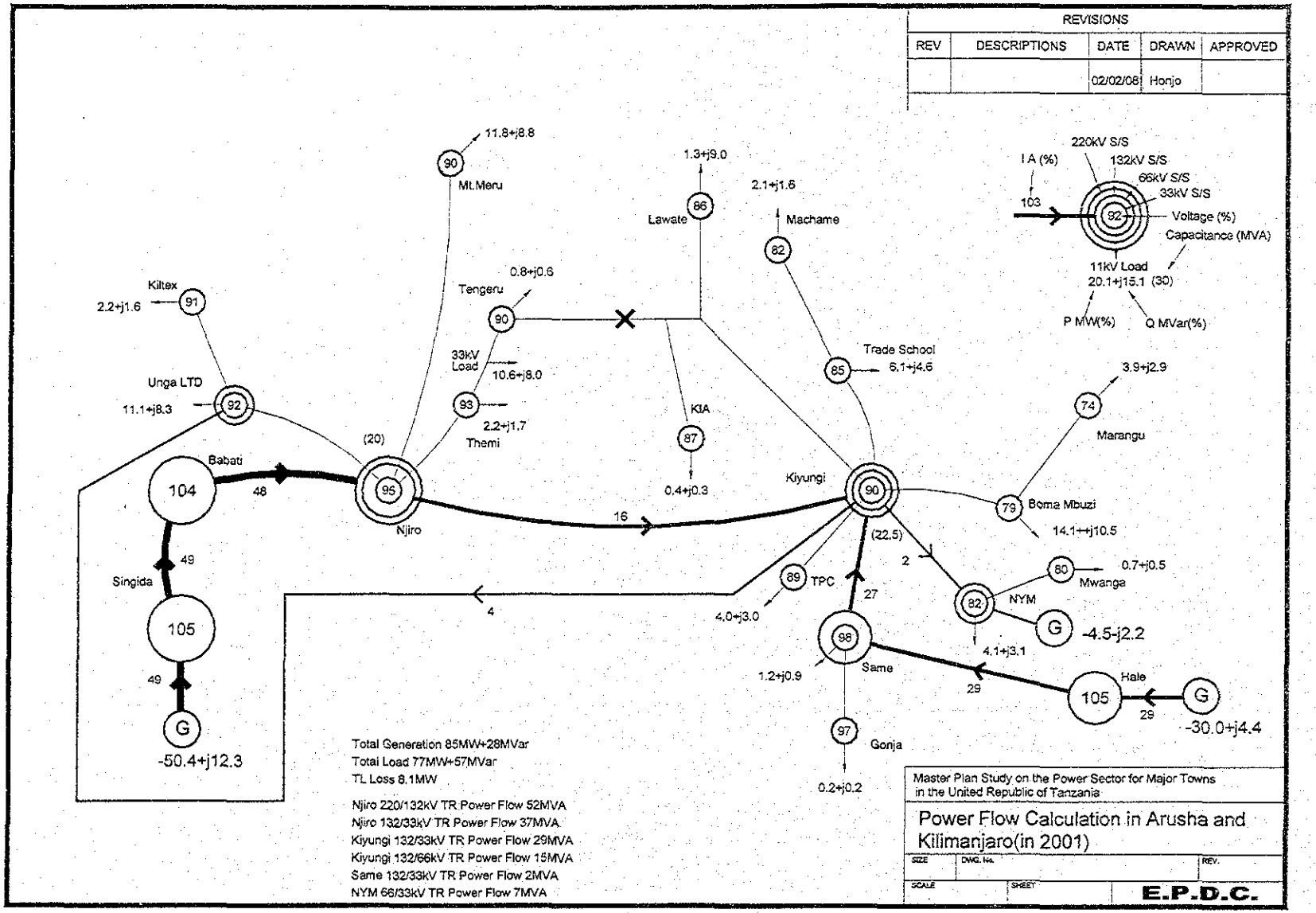

Fig. 6.9 Power Flow Calculation in Arusha and Moshi 2001

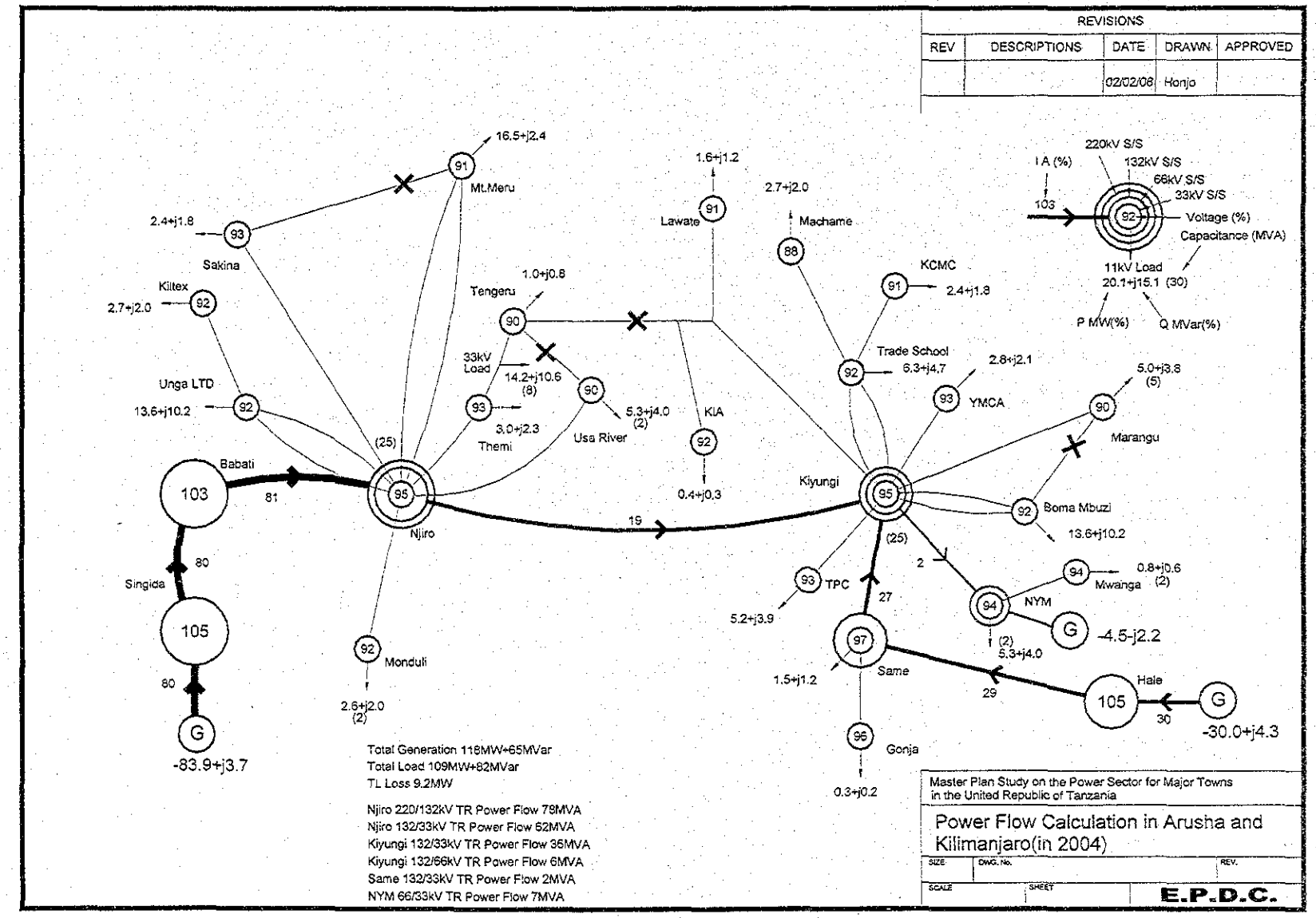

Fig. 6.10 Power Flow Calculation in Arusha and Moshi 2004

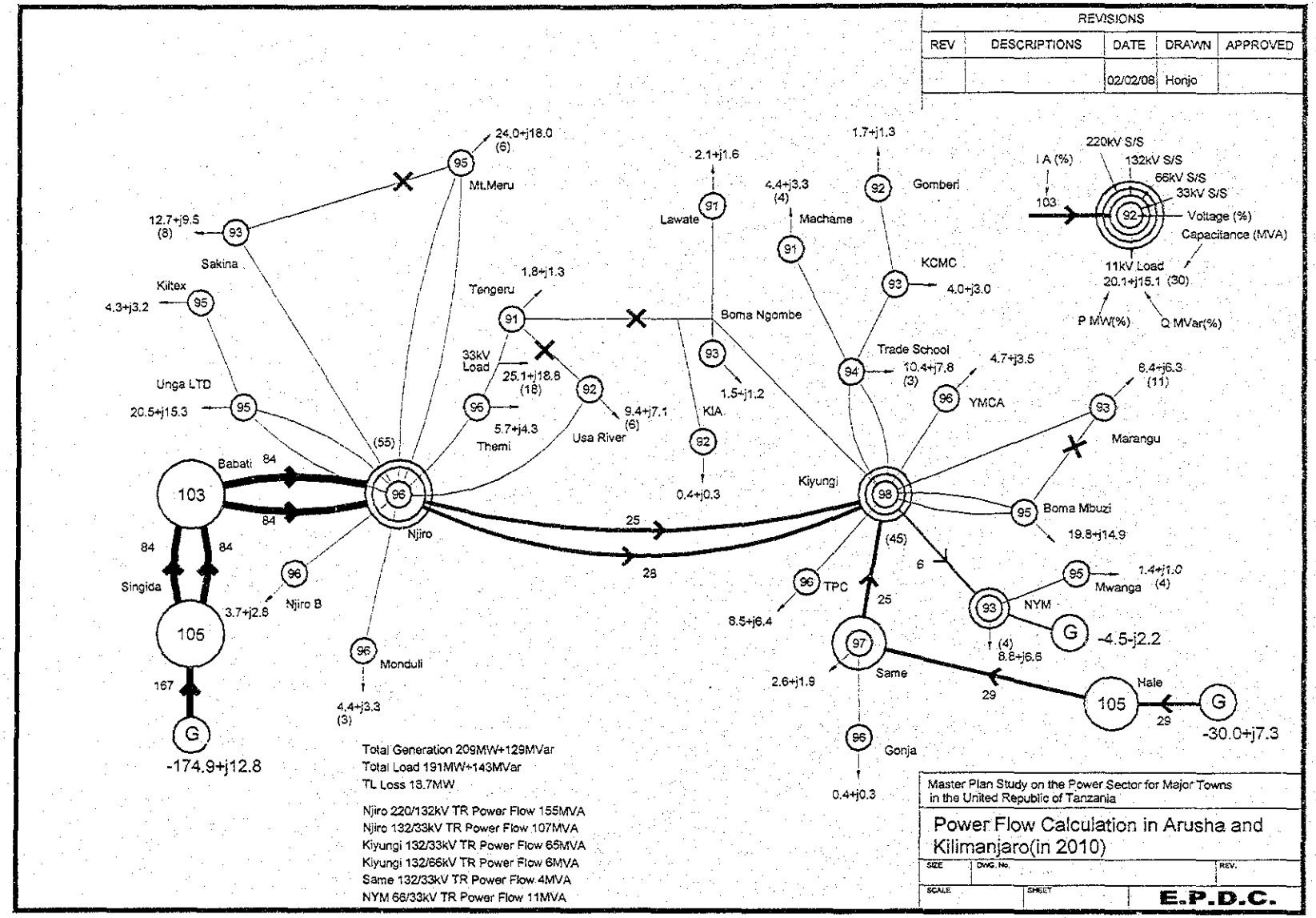

Fig. 6.11 Power Flow Calculation in Arusha and Moshi 2010

6.3.2 Concept of Expansion Plan for Each Year

(1) 2001

The substations that were found to be under an overload during the on-site study are the Mt. Meru S/S, Unga LTD S/S, Boma Mbuzi S/S, and Trade School S/S. It is to be desired that these substations should be expanded as early as possible.

(2) 2002

The substations that have experienced an overload during 2001 shall be expanded. The YMCA S/S is under construction in 2001 and scheduled for completion in 2002.

The expansion of the 132 kV/33 kV transformer of the Njiro S/S forms the base of the expansion plan in Arusha Region, hence it needs to be carried out within this year ahead of other expansion projects.

Concerning the Kiyungi S/S, the obsolescent 66 kV/33 kV transformer that leaks a considerable amount of insulating oil shall be removed and a new 132 kV/33 kV transformer shall be installed. TANESCO proposed that a new 66 kV substation should be constructed in Marangu Area. Considering that the forecast demand for 2010 is about 10 MVA and that Marangu Area is a 33 kV distribution area, it was decided to construct a 33 kV switching station which does not require transformers in the area and lead a 33 kV transmission line to the switching station directly from the Kiyungi S/S.

Concerning the existing 33 kV transmission lines, the reinforcement of the 33 kV transmission lines between the Kiyungi S/S and Trade School S/S and between the Kiyungi S/S and Boma Mbuzi S/S, suggested by TANESCO, shall be carried out within this year, together with the reinforcement of the Kiyungi S/S. In addition, the transformer of the Machame S/S that needs expansion sometime in the future is planned to be replaced with a new 5 MVA transformer within this year.

(3) 2003

The Unga LTD S/S and Kiltex S/S are both situated at the load center in Arusha. Since the entire equipment of those substations has deteriorated due to many years of overload operation, it was decided to renew the whole equipment within this year. In addition, Usa River S/S and Monduli S/S are planned to be constructed in this year. This will significantly expand Arusha's 33 kV distribution network east and west.

(4) 2004

In Arusha, the area along the Nairobi-Moshi road is rapidly expanding in population. In order to cope with the ever increasing demand for electric power, Sakina S/S shall be constructed in this year. By so doing, it becomes possible to shift part of the load of the Mt. Meru S/S to the new substation. Also, by constructing a 33 kV transmission line between the Mt. Meru S/S and Sakina S/S, it becomes possible to operate the two substations flexibly.

TANESCO proposed that a new 132 kV substation should be constructed at KCMC area. According to the Master Plan up to the year 2010, however, the Kiyungi S/S alone is sufficient as the primary substation within Moshi City, hence it was decided to install a 33 kV substation instead of a 132 kV substation. Since the 33 kV transmission line between the Kiyungi S/S and Trade School S/S will have been reinforced in 2002, it was decided that the 33 kV transmission line to the KCMC S/S should be led from the bus of the Trade School S/S.

(5) 2005

According to the Arusha Regional Office, there is a plan to construct a new 33 kV substation near the Njiro S/S. Eventually, it was decided to put the new substation into operation in this year. Concerning the time to start construction of the substation, it is necessary to discuss it with the Arusha Regional Office.

(6) 2006

If the Hale-Kiyungi 132kV transmission line fails, it is necessary to meet the power demand of the two cities via the 220 kV/132 kV transformers of the Njiro S/S. Since the total load in Arusha and Moshi will increase to about 150 MVA in 2006, it was decided to expand the 220 kV/132 kV transformer of the Njiro S/S in this year. At the same time, the 132 kV/33 kV transformer of the Njiro S/S and the 132 kV transmission line between the Njiro S/S and Kiyungi S/S shall be expanded. According to the former Master Plan for power stations and trunk transmission lines up to the year 2025, the 220 kV transmission line between Singida and Arusha will have been duplicated by 2006 to 2010. Therefore, the expansion of the facilities mentioned above must be carried out with due consideration given to the timing of reinforcement of the Singida-Arusha transmission line.

(7) 2007-2010

The Themi S/S, Boma Ngombe S/S, Usa River S/S, Sakina S/S, and Kiyungi S/S shall be constructed/expanded as required to cope with the increase in load.

6.3.3 Supplementary Explanation

The existing 66 kV transmission line between the Kiyungi S/S and Unga LTD S/S was constructed in 1967 and has deteriorated markedly. Since the conductor is thin (50 mm^2) and the current capacity is not more than about 200 A, the transmission line will not contribute much to the assurance of reliability of power supply in the area even if it is repaired at a large cost. If the 132 kV transmission line between the Njiro S/S and Kiyungi S/S is expanded, it becomes possible to remove the 66 kV transmission line. To maintain the necessary voltage, it is necessary to install a capacitor bank of about 10 MVA/year in this area.

6.4 Expansion Plan (Case-B) Taking Load Shedding and Overload into Account

6.4.1 Overload Operation and Load Shedding

During the field survey, TANESCO's distribution substations in the Dar es Salaam, Arusha, and Kilimanjaro areas were found to be in overload operation. According to the engineers of TANESCO, load shedding was implemented as required to avoid overload operation of the distribution substations. In Case-A, it is assumed that the overload operation of any of the existing facilities shall be immediately stopped and that any of the existing facilities shall be expanded at the time when the substation peak load exceeds the capacity of the facility. This expansion plan (Case-A) is very advantageous in terms of the reliability of power supply and the operation of facilities. On the other hand, it has the disadvantage of calling for the advance of project investment as a whole, which means a larger amount of investment in the early periods of the master plan.

As can be seen from the annual load duration curve at TANESCO (Fig. 12.1 in Chapter 12), assuming the peak load of the year as 100%, the duration of 90% or more load comes to about 300 hours. Therefore, if the shedding of loads exceeding 90% only is allowed for only 300 hours, the demand during the other period can be met even with 90% of the substation installed capacity.

Assume, for example, that the peak load of the year at a 30 MVA substation is 36 MVA. From the load duration model shown in Fig. 12.2, the time for which the substation is operated under a load exceeding 30 MVA is 805 hours. The amount of electric power that cannot be supplied as a result of load shedding can be calculated by integrating the load portions exceeding 30 MVA. Thus, the unserved energy is only 1,385 MWh. Since the transformer has a certain allowance for overload operation, if it is allowed to operate under an overload, the unserved energy becomes still smaller.

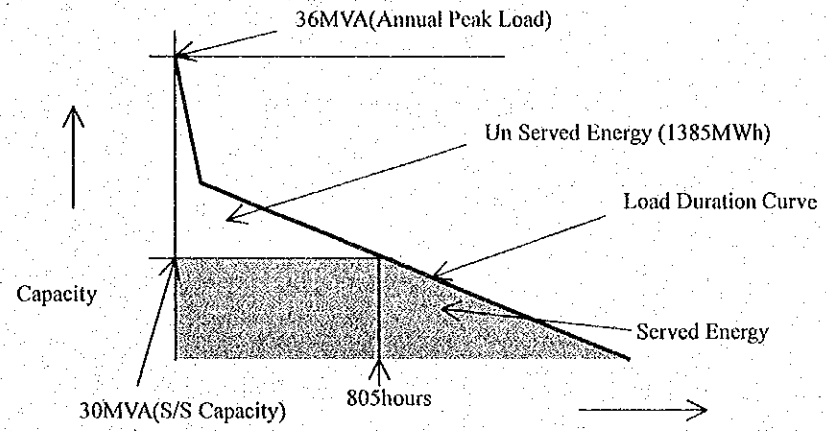

Fig. 6.12 Estimation of Unserved Energy

6.4.2 Expansion Plan (Case-B)

(1) Plan formulation policy

The load shedding and overload operation of transformers and transmission lines shall be taken into account. Concretely, any transformer shall be expanded at the time when the maximum load reaches 120% of the transformer installed capacity, and the construction of new substations planned in Case-A, excepting those which are being constructed, shall be postponed one year.

(2) Dar es Salaam

The differences from Case-A are as follows.

Construction of new Kawe S/S, new Kunduchi S/S, new Muhimbili S/S, new Kigogo S/S, new Kinondoni S/S, new TOL S/S, new Mburahati S/S, and new UDSM S/S; installation of 2nd TR of Sokoine S/S, Tandale S/S; FZ III S/S(33 kV), installation of 3rd TR of Msasani S/S

→ To be postponed 1 year.

Expansion of Mbezi S/S; installation of additional 33 kV TRs of Kurasini S/S and Mbagala S/S; installation of 2nd TR of Msasani S/S

→ To be postponed 2 years.

Installation of additional 33 kV TR of Ilala S/S; installation of 2nd TR of Kariakoo S/S, Chang'ombe S/S, and Bahari Beach S/S

→ To be postponed 3 years.

Installation of fifth 33 kV TR of Ilala S/S

→ To be postponed 4 years.

Expansion of 132 kV TR in Ubungo S/S and 3rd 33 kV TR of FZ III S/S; expansion of Tandika S/S and TOL S/S

→ To be postponed until 2010 or after.

The expansion plan (Case-B) in the Dar es Salaam area is shown in Table 6.5.

(3) Arusha and Moshi

Arusha:

Construction of new Usa River S/S, new Monduli S/S, new Sakina S/S, new Njiro B S/S, and expansion of Themi S/S

→ To be postponed 1 year.

Expansion of Sakina S/S and Usa River S/S

→ To be postponed until 2010 or after.

Moshi:

Construction of new Gomberi S/S, new KCMC S/S, and new Boma Ngombe S/S; expansion of Machame S/S

→ To be postponed 1 year.

Expansion of Kiyungi S/S (installation of 2nd 132/33 kV 45 MVA TR)

→ To be postponed until 2010 or after.

The expansion plans (Case-B) in Arusha and Moshi are shown in Table 6.6.

Table 6.5 Transmission Line/Substation Expansion Plan (Case-B) in Dar es Salaam area up until 2010

Year	Name of S/S	Specification	Type	Remark	Name of Transmission Line	Specification	Type	Remark
2002	Mbezi S/S	33kV 15MVAx1	R/E	2x5-->1x15				
	Bahari Beach S/S	33kV 15MVAx1	New	On Going	Tegeta-Bahari Beach	33kV 100mm^2 2cdt 13km	New	On Going 1cct
	Bagamoyo S/S	33kV 5MVAx1	New		Tegeta-Bagamoyo	33kV 100mm^2 2cdt 60km	New	On Going 2cct
	City Center S/S	33kV 30MVAx1	R/E	1x15-->1x30				
	Kurasini S/S	Switchgear	Replace					
	Ubungo S/S	33kV 15MVAx1	Expansion	On Going				
	Mikocheni S/S	33kV 15MVAx1	Expansion					
	Magomeni S/S	33kV 15MVAx1	New	On Going	Magomeni-Magomeni Tap	33kV 100mm^2 1cdt 1km	New	
	Tandika S/S	33kV 15MVAx1	New		FZ III-Tandilka	33kV 100mm^2 2cdt 5km	New	1cct
	FZ III S/S	33kV Leadout	Expansion	Tandika Line				
	FZ I S/S	Panel, others	Replace					
	FZ II S/S	Switchgear etc	Replace					
2003	Sokoine S/S	33kV 15MVAx1	Expansion		City Center-Sokoine	33kV 100mm^2 1cdt 3km	Reinforce	
	City Center S/S	33kV Leadout	Expansion	Sokoine Line				
	Tandale S/S	33kV 15MVAx1	Expansion		Ubungo-Tandale Tap	33kV 100mm^2 2cdt 1km	New	2cct
	Ubungo S/S	33kV Leadout	Expansion	Tandale Line				
	FZ III S/S	33kV 15MVAx1	Expansion					
	New Oysterbay S/S	132kV 45MVAx2	New		Ubungo-New Oysterbay	132kV 240mm^2 1cdt 8.5km	New	
		33kV 15MVAx2						
	Ubungo S/S	132kV Leadout	Expansion	NOB Line				
	Oysterbay S/S	33kV 15MVAx1	R/E	2x5-->1x15	New Oysterbay-Oysterbay	33kV 150mm^2 2cdt 1.6km	New	1cct
2004	Mbagala S/S	33kV 15MVAx1	Expansion					
	Muhimbili S/S	33kV 15MVAx1	New		Ilala-Muhimbili	33kV 100mm^2 1cdt 6km	New	
	Ilala S/S	33kV Leadout	Expansion	Muhimbili Line				
	TOL S/S	33kV 15MVAx1	New		Ilala-TOL	33kV 100mm^2 2cdt 5km	New	1cct
	Ilala S/S	33kV Leadout	Expansion	TOL Line				
	University S/S	33kV 15MVAx1	New		Ubungo-University	33kV 100mm^2 1cdt 7km	New	
	Ubungo S/S	33kV Leadout	Expansion	University Line				
	Yombo S/S	132kV 45MVAx1	New		FZ III-Yombo	132kV 240mm^2 1cdt 8.5km	New	
		33kV 15MVAx1	New					
	FZ III S/S	132kV Leadout	Expansion	Yombo Line				
					Yombo-Mbagala	132kV 240mm^2 1cdt 10km	New	
	Kitunda S/S	33kV 15MVAx1	New		Yombo-Kitunda	33kV 100mm^2 1cdt 3.9km	New	
	Mbagala S/S	132kV 45MVAx1	Expansion		Kurasini-Mbagala	132kV 240mm^2 1cdt 16km	New	
	Kurasini S/S	132kV 45MVAx2	Expansion		Ilala-Kurasini	132kV 240mm^2 1cdt 10km	New	
	Ilala S/S	132kV Leadout	Expansion	Kurasini Line				
	Kurasini S/S	33kV 15MVAx1	Expansion		Ilala-Kurasini	33kV 150mm^2 1cdt 7.1km	Reconductor	

R/E: Replace and Expansion

Year	Name of S/S	Specification	Type	Remark	Name of Transmission Line	Specification	Type	Remark
2005	Mburahati S/S	33kV 15MVAx1	New		Ubungo-Mburahati	33kV 100mm^2 1cdt 4km	New	
	Ubungo S/S	33kV Leadout	Expansion	Mburahati Line				
	Msasani S/S	33kV 15MVAx1	Expansion		New Oysterbay-Msasani	33kV 150mm^2 2cdt 5km	New	1cct
2006	Kinondoni S/S	33kV 15MVAx1	New		Mikocheni-Kinondoni	33kV 100mm^2 1cdt 8km	New	
	Mikocheni S/S	33kV Leadout	Expansion	Kinondoni Line				
	Kawe S/S	33kV 15MVAx1	New		Mbezi-Kawe	33kV 100mm^2 1cdt 9km	New	
	Mbezi S/S	33kV Leadout	Expansion	Kawe Line				
	City Center S/S	33kV 30MVAx1	R/E	1x15-->1x30				
	Kurasini S/S	33kV 15MVAx1	Replace					
	Ilala S/S	132kV 45MVAx1	Expansion		Ubungo-Ilala	132kV 240mm^2 1cdt 7.5km	Reinforce	
		33kV 15MVAx1	Expansion		Ilala-City Center #2	33kV 100mm^2 1cdt 2.8km	Reconductor	1cct
2007	Bahari Beach S/S	33kV 15MVAx1	Expansion					
	Tegeta S/S	33kV Leadout	Expansion	Bahari Beach Line				
	Kunduchi S/S	33kV 15MVAx1	New		Tegeta-Kunduchi	33kV 100mm^2 1cdt 3.2km	New	
	Tegeta S/S	33kV Leadout	Expansion	Kunduchi Line				
	Kigogo S/S	33kV 15MVAx1	New		Ilala-Kigogo	33kV 100mm^2 1cdt 12km	New	
	Ilala S/S	33kV Leadout	Expansion	Kigogo Line				
					Tegeta-Mbezi	33kV 100mm^2 1cdt 8.4km	Reinforce	
2008	Chang'ombe S/S	33kV 15MVAx1	Expansion		Kurasini-Chang'ombe	33kV 120mm^2 1cdt 3km	Reinforce	
2009	Mbezi S/S	33kV 15MVAx1	Expansion					
	Tegeta S/S	33kV Leadout	Expansion	Mbezi Line				
	Msasani S/S	33kV 15MVAx1	Expansion					
2010	Kariakoo S/S	33kV 15MVAx1	Expansion		Ilala-Kariakoo	33kV 100mm^2 1cdt 1.3km	Reinforce	
	Ilala S/S	33kV Leadout	Expansion	Kariakoo Line				
	Ilala S/S	33kV 15MVAx1	Expansion					

Table 6.6 Transmission Line/Substation Expansion Plan (Case-B) in Arusha, Kilimanjaro area up until 2010

Year	Name of S/S	Specification	Type	Remark	Name of Transmission Line	Specification	Type	Remark
2002	Njiro S/S	Switchgear	Replace					
		132kV 45MVAx1	Expansion					
	Mt. Meru S/S	33kV 10MVAx3	Expansion		Njiro-Mt.Meru	33kV 100mm^2 7.3km	Reinforce	
	Kiyungi S/S	Switchgear etc	Replace					
		132/33kV 45MVAx1	Expansion					
	Boma Mbuzi S/S	Switchgear etc	Replace		Kiyungi-Boma Mbuzi	33kV 100mm^2 7km	Reinforce	
		33kV 10MVAx1	Expansion					
	Trade School S/S	33kV 10MVAx1	R/E		Kiyungi-Trade School	33kV 100mm^2 10km	Reinforce	
	YMCA S/S	33kV 10MVAx1	New	On going				
	Marangu Sw/S	33kV	New		Kiyungi-Marangu	33kV 100mm^2 43km	New	
2003	Unga LTD S/S	33kV 10MVAx3	R/E	2x5-->3x10	Njiro-Unga LTD	33kV 100mm^2 5.8km	Reinforce	
	Kiltex S/S	33kV 10MVAx1	R/E	1x5-->1x10				
	Machame S/S	33kV 5MVAx1	R/E	1x2.5-->1x5				
	Same S/S	Switchgear etc	Replace					
2004	Usa River S/S	33kV 10MVAx1	New		Njiro-Usa River	33kV 100mm^2 21.3km	New	
					Tengeru-Usa River	33kV 100mm^2 12.5km	New	
	Monduli S/S	33kV 10MVAx1	New		Njiro-Monduli	33kV 100mm^2 38.6km	New	
2005	Sakina S/S	33kV 10MVAx1	New		Njiro-Sakina	33kV 100mm^2 13.2km	New	
					Mt.Meru-Sakina	33kV 100mm^2 8.1km	New	
					Njiro-Kiyungi	132kV 240mm^2 70km	Reinforce	(1/2)
	KCMC S/S	33kV 10MVAx1	New		Trade School-KCMC	33kV 100mm^2 3.7km	New	
	Trade School S/S	33kV Leadout	Expansion	KCMC Line				
2006	Njiro B S/S	33kV 10MVAx1	New		Njiro-Njiro B	33kV 100mm^2 3km	New	
	Njiro S/S	220kV 60MVAx1	Expansion					
		132kV 45MVAx1	Expansion		Njiro-Kiyungi	132kV 240mm^2 70km	Reinforce	(2/2)
	KCMC S/S	33kV Leadout	Expansion	Gomberi Line				
	Kiyungi S/S	132kV Leadout	Expansion	Njiro Line				
2007	Gomberi S/S	33kV 5MVAx1	New		KCMC-Gomberi	33kV 100mm^2 4.9km	New	
2008	Themi S/S	33kV 10MVAx1	Expansion					
	Boma Ngombe S/S	33kV 5MVAx1	New					
2009								
2010								

R/E: Replace and Expansion